

In the Office Action dated September 18, 2002, claims 1-34 were rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 4,989,943 to Yoshinaga et al.

Applicant respectfully traverses the rejection of the claims over the cited art, and submits that various novel and non-obvious features of the present invention are not taught or disclosed by the cited art. Nevertheless, independent claims 1, 10, 16, and 29 have been amended herein to more clearly define the invention.

In one aspect of the invention, independent claims 1 and 16 each recite a plastic optical fiber with a lens. The lens has a function of controlling light rays and is formed of a material with a thermally-softening temperature higher than a thermally-softening temperature of the core of the plastic optical fiber. At least a part of the lens is embedded in an end face of the plastic optical fiber.

In another aspect, independent claims 10 and 29 each recite a method of fabricating a plastic optical fiber with a lens. Each method includes the steps of preparing a thermally-conductive substrate for holding the lens in a predetermined position on the substrate; holding the lens in the predetermined position on the substrate; heating the substrate and the lens held thereby to a temperature below a thermally-softening temperature of the lens and above a thermally-softening temperature of a core of a plastic optical fiber; and pressing an end face of the plastic optical fiber against the heated lens to embed at least a part of the lens in the end face of the plastic optical fiber.

As such, as recited in each of the embodiments of claims 1, 10, 16, and 29, at least a portion of the lens is embedded in an end face of the plastic optical fiber.

Applicant submits that the cited art does not teach or suggest at least this feature of the present invention.

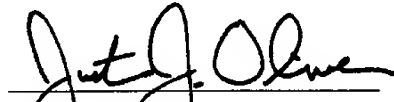
The Yoshinaga patent relates to an optical fiber alignment device. In particular, the Yoshinaga patent discloses an optical circuit device in which an elastic inner sleeve 14 holds an optical fiber 10 and a lens 12 on the same optical axis. The inner sleeve 14 is held by an intermediate sleeve 16, which is in turn held by an outer sleeve 18. As such, the optical fiber 10 and the lens 12, while both held by the same inner sleeve 14, are held spaced apart from each other. The Yoshinaga patent, therefore, fails to teach or suggest that at least a portion of the lens is embedded at an end face of the plastic optical fiber, as disclosed in each of independent claims 1, 10, 16, and 29. Applicant also submits that it would not have been obvious to alter the teaching of the Yoshinaga patent to include at least such a feature. Accordingly, Applicant requests withdrawal of the rejection under 35 U.S.C. § 103.

Applicant submits that the present invention, as recited in independent claims 1, 10, 16, and 29, is patentable over the cited art. Dependent claims 2-9, 11-15, 17-28, and 30-34 also should be deemed allowable, in their own right, for defining other patentable features of the present invention in addition to those recited in their respective independent claims. Further individual consideration of these dependent claims is requested.

Applicant submits that the instant application is in condition for allowance. Favorable reconsideration, withdrawal of the rejection set forth in the above-noted Office Action, and an early Notice of Allowance are requested.

Applicant's undersigned attorney may be reached in our Washinton, D.C. office by telephone at (202) 530-1010. All written correspondence should continue to be directed to our below listed address.

Respectfully submitted,


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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO CLAIMS

1. (Amended) A plastic optical fiber with a lens comprising:
a plastic optical fiber including a core and a cladding; and
a lens having a function of controlling light rays, said lens being formed of a material with a thermally-softening temperature higher than a thermally-softening temperature of said core, and at least a part of said lens being embedded in [integrated with said plastic optical fiber by heating and pressing said lens against] an end face of said plastic optical fiber.

10. (Amended) A method of fabricating a plastic optical fiber with a lens, said method comprising the steps of:
preparing a thermally-conductive substrate for holding a lens in a predetermined position;
holding the lens in the predetermined position on the substrate;
heating the substrate and the lens held thereby to a temperature below a thermally-softening temperature of the lens and above a thermally-softening temperature of a core of a plastic optical fiber; and
pressing an end face of the plastic optical fiber against the heated lens to embed at least part of [mold the end face of the plastic optical fiber to integrate] the lens

[with] in the end face of the plastic optical fiber and cause an end of the plastic optical fiber to have a function of controlling light rays.

12. (Amended) The method of fabricating a plastic optical fiber with a lens according to claim 11, wherein in said preparing step the thermally-conductive substrate is prepared such that an adjusting surface for adjusting a positional relationship in an optical-axial direction between the lens and the plastic optical fiber is also formed near the portion with a contour for holding the lens, and in said pressing step a periphery of the end face of the plastic optical fiber is caused to abut the adjusting surface when the lens is embedded in the end face of the plastic optical fiber [is pressed against the heated lens].

13. (Amended) The method of fabricating a plastic optical fiber with a lens according to claim 10, further comprising the step of providing an alignment member for holding an end portion of the plastic optical fiber and aligning optical axes of the lens and the plastic optical fiber with each other on the substrate, wherein the optical axes of the lens and the plastic optical fiber are caused to align with each other when the lens is embedded in the end face of the plastic optical fiber [is pressed against the heated lens] in said pressing step.

15. (Amended) The method of fabricating a plastic optical fiber with a lens according to claim 10, further comprising the step of bonding the lens to the plastic optical fiber at a peripheral portion of the lens with an adhesive.

16. (Amended) [A light-emitting/receiving] An apparatus comprising:
a [light-emitting/receiving] light-emitting device or a light-receiving device,
arranged on a substrate;
a plastic optical fiber including a core and a cladding; and
a lens having a function of controlling light rays, said lens being arranged
above said [light-emitting/receiving] device and formed of a material with a
thermally-softening temperature higher than a thermally-softening temperature of said core,
and at least a part of said lens being embedded in [integrated with said plastic optical fiber
by having been heated and pressed against] an end face of said plastic optical fiber.

17. (Amended) The [light-emitting/receiving] apparatus according to
claim 16, wherein said substrate has a portion for holding said lens in a predetermined
position, said portion being formed directly or indirectly on said substrate.

18. (Amended) The [light-emitting/receiving] apparatus according to
claim 17, wherein an adjusting surface for adjusting a positional relationship in an
optical-axial direction between said lens and said plastic optical fiber is also formed near

said portion for holding said lens, and a periphery of the end face of said plastic optical fiber abuts said adjusting surface.

19. (Amended) The [light-emitting/receiving] apparatus according to claim 18, wherein said lens has a diameter smaller than a diameter of said plastic optical fiber, said portion for holding said lens comprises a recess whose size is larger than the diameter of said lens and smaller than the diameter of said plastic optical fiber, and said adjusting surface comprises a surface around said recess.

20. (Amended) The [light-emitting/receiving] apparatus according to claim 17, wherein said portion for holding said lens is formed integrally with said lens and of a material common to said lens and integrally with said lens.

21. (Amended) The [light-emitting/receiving] apparatus according to claim 16, wherein said substrate is provided with an alignment member for holding an end portion of said plastic optical fiber and aligning optical axes of said lens and said plastic optical fiber with each other.

22. (Amended) The [light-emitting/receiving] apparatus according to claim 16, wherein said lens is a light-condensing lens having a spherical surface.

23. (Amended) The [light-emitting/receiving] apparatus according to claim 22, wherein said lens is a ball lens.

24. (Amended) The [light-emitting/receiving] apparatus according to claim 16, wherein said lens is a light-condensing lens having a semispherical surface.

25. (Amended) The [light-emitting/receiving] apparatus according to claim 16, wherein said lens is formed of glass.

26. (Amended) The [light-emitting/receiving] apparatus according to claim 16, wherein said lens is formed of polymer.

27. (Amended) The [light-emitting/receiving] apparatus according to claim 16, wherein said plastic optical fiber is totally-fluorine-contained plastic optical fiber.

28. (Amended) The [light-emitting/receiving] apparatus according to claim 16, wherein said lens is bonded to said plastic optical fiber at a peripheral portion of said lens with an adhesive.

29. (Amended) A method of fabricating [a light-emitting/receiving] an apparatus, said method comprising the steps of:

preparing a thermally-conductive substrate for arranging in a predetermined position a [light-emitting/receiving] light-emitting device or a light-receiving device, and for holding a lens in a predetermined [positions, respectively] position on the substrate;

arranging the [light-emitting/receiving] device in the predetermined position on the substrate;

holding the lens in the predetermined position on the substrate; and

heating the substrate and the lens held thereby to a temperature below a thermally-softening temperature of the lens and above a thermally-softening temperature of a core of a plastic optical fiber; and

pressing an end face of the plastic optical fiber against the heated lens to [mold the end face of the plastic optical fiber to integrate] embed at least a part of the lens [with] in the end face of the plastic optical fiber and cause an end of the plastic optical fiber to have a function of controlling light rays.

30. (Amended) The method of fabricating [a light-emitting/receiving] an apparatus according to claim 29, wherein in said preparing step the thermally-conductive substrate is prepared such that a portion for holding the lens in the predetermined position is formed directly or indirectly on the thermally-conductive substrate.

31. (Amended) The method of fabricating [a light-emitting/receiving] an apparatus according to claim 30, wherein in said preparing step the thermally-conductive substrate is prepared such that an adjusting surface for adjusting a positional relationship in an optical-axial direction between the lens and the plastic optical fiber is also formed near the portion for holding the lens, and, in said pressing step, a periphery of the end face of the plastic optical fiber is caused to abut the adjusting surface when the lens is embedded in the end face of the plastic optical fiber [is pressed against the heated lens].

32. (Amended) The method of fabricating [a light-emitting/receiving] an apparatus according to claim 29, further comprising the step of providing an alignment member for holding an end portion of the plastic optical fiber and aligning optical axes of the lens and the plastic optical fiber with each other on the substrate, wherein the optical axes of the lens and the plastic optical fiber are caused to align with each other when the lens is embedded at the end face of the plastic optical fiber [is pressed against the heated lens] in said pressing step.

33. (Amended) The method of fabricating [a light-emitting/receiving] an apparatus according to claim 29, wherein the lens held in said holding step has a diameter smaller than a diameter of the plastic optical fiber.

34. (Amended) The method of fabricating [a light-emitting/receiving] an apparatus according to claim 29, further comprising the step of bonding the lens to the plastic optical fiber at a peripheral portion of [said] the lens with an adhesive.

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